

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
 US Department of Commerce
 United States Patent and Trademark
 Office, PCT
 2011 South Clark Place Room
 CP2/5C24
 Arlington, VA 22202
 ETATS-UNIS D'AMERIQUE
 in its capacity as elected Office

Date of mailing (day/month/year) 22 November 2000 (22.11.00)	Applicant's or agent's file reference DCR P21205WO
International application No. PCT/GB00/01070	
International filing date (day/month/year) 21 March 2000 (21.03.00)	Priority date (day/month/year) 23 March 1999 (23.03.99)
Applicant NILSEN, Finn, Patrick et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:

16 October 2000 (16.10.00)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
 34, chemin des Colombettes
 1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

Zakaria EL KHODARY

Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

To:

REES, David, Christopher
 Kilburn & Strode
 20 Red Lion Street
 London WC1R 4PJ
 ROYAUME-UNI

RECEIVED
 MAY 10 2002
 TC 1799

**NOTIFICATION OF THE RECORDING
 OF A CHANGE**

(PCT Rule 92bis.1 and
 Administrative Instructions, Section 422)

Date of mailing (day/month/year) 05 October 2001 (05.10.01)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference DCR P21205WO	
International application No. PCT/GB00/01070	International filing date (day/month/year) 21 March 2000 (21.03.00)

1. The following indications appeared on record concerning:

☒ the applicant ☐ the inventor ☐ the agent ☐ the common representative

Name and Address

DEN NORSKE STATS OLJESELSKAP A.S.
 N-4035 Stavanger
 Norway

State of Nationality

NO

State of Residence

NO

Telephone No.

Facsimile No.

Teleprinter No.

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☒ the name ☐ the address ☐ the nationality ☐ the residence

Name and Address

STATOIL ASA
 N-4035 Stavanger
 Norway

State of Nationality

NO

State of Residence

NO

Telephone No.

Facsimile No.

Teleprinter No.

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office ☐ the designated Offices concerned
☐ the International Searching Authority ☒ the elected Offices concerned
☐ the International Preliminary Examining Authority ☐ other:

The International Bureau of WIPO
 34, chemin des Colombettes
 1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

S. Buttay

Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference DCR P21205WO	FOR FURTHER ACTION <small>see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.</small>	
International application No. PCT/GB 00/ 01070	International filing date (day/month/year) 21/03/2000	(Earliest) Priority Date (day/month/year) 23/03/1999
Applicant DEN NORSKE STATS OLJESELSKAP A.S.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☐ Unity of invention is lacking (see Box II).

4. With regard to the title,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

2

☐ None of the figures.

INTERNATIONAL SEARCH REPORT

national Application No

PCT/GB 00/01070

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 C10L3/10 53/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 IPC 7 C10L B01D C10G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 301 048 A (KCC PROCESS EQUIPMENT LTD) 27 November 1996 (1996-11-27) the whole document	1,6,9, 13,15, 19,23, 24,27,30
A	US 4 279 628 A (WYMER ROBERT L ET AL) 21 July 1981 (1981-07-21)	



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

26 June 2000

Date of mailing of the international search report

05/07/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5618 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
 Fax: (+31-70) 340-3016

Authorized officer

De Herdt, O

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 00/01070

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
GB 2301048	A	27-11-1996	NONE	
US 4279628	A	21-07-1981	NONE	

REC'D 27 JUN 2001

AmO PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

14

Applicant's or agent's file reference DCR P21205WO		FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/GB00/01070	International filing date (day/month/year) 21/03/2000	Priority date (day/month/year) 23/03/1999	
International Patent Classification (IPC) or national classification and IPC C10L3/10			
Applicant DEN NORSKE STATS OLJESELSKAP A.S. et al.			

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of 5 sheets, including this cover sheet.

- ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 16/10/2000	Date of completion of this report 25.06.01
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Falls, F Telephone No. +49 89 2399 8350 

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/01070

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-10 as originally filed

Claims, No.:

1-32 as originally filed

Drawings, sheets:

1/3-3/3 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/01070

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-32
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-29
	No:	Claims	30-32
Industrial applicability (IA)	Yes:	Claims	1-32
	No:	Claims	

2. Citations and explanations
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

1). Prior Art

US-A-4279628(D1) discloses a vessel for drying gas in which gas is introduced via a venturi inlet into a mixing zone where turbulent mixing takes place, the gas and liquid being removed through separate outlets.

2). Novelty (Art. 33(2) PCT)

D1 does not disclose the following features of the claims:

- The venturi **leads from** the liquid-gas outlet.
- In claim 1 the liquid and gas are led out through the same outlet; in D1 they exit through separate outlets.
- The internal tube which is either perforated or spaced from the periphery of the outlet.

Therefore the subject-matter of the claims is novel.

3). Inventive Step (Art. 33(3) PCT)

The problem is to improve the method for removing water vapour from natural gas.

The inventive concept resides in the combination of the turbulent contactor and tube followed by drawing of the liquid and gas mixture through the outlet into the venturi, which allows for rapid and efficient mixing in a relatively small total volume giving efficient absorption (see pg 3, l. 19-30). Therefore the subject-matter of claims 1-29 is inventive.

In view of the fact that claims 30-32 for the use of the turbulent contractor for absorbing water from a natural gas stream do not contain all features essential for carrying out this aspect of the invention (see section II(1) below), the subject-matter of these claims is not inventive across the breadth of the claims.

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB00/01070

II

The following matters arise under Art. 6 PCT:

1). It is clear from the description on page 3 that the following features are essential to the definition of the invention:

- (i) The tube being perforated and/or spaced from the periphery outlet.
- (ii) Subjecting the natural gas and liquid to turbulent mixing.

Since independent claim 30 for the use of the apparatus of claim 24 does not contain these features it does not meet the requirement following from Article 6 PCT taken in combination with Rule 6.3(b) PCT that any independent claim must contain all the technical features essential to the definition of the invention.

2). Claims 2 and 25 appear to be superfluous since it seems that in accordance with the definition of the process in claim 1 "the tube extending from the outlet back upstream" would necessarily be located inside the turbulent contacting vessel along with the gas and liquid inlets and the outlet (e.g as in Fig 2). It appears therefore that these claims should be deleted.

3). The passage on pg 3, l. 14-16 suggests that the scope of protection may be extended to gases other than natural gas without giving any teaching as to what these are. Therefore since the passage suggests that the scope of protection may be extended in an undefined way, it should be deleted.

4). The word "preferably" on pg 4, l. 8 should be deleted since the feature referred to is essential (see (2) above).

PC

PTO/PC/REQUEST 2001

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

Receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference
(if desired) (12 characters maximum) DCR P21205WO

Box No. I TITLE OF INVENTION

Method and Apparatus for the Drying of Natural Gas

Box No. II APPLICANT

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

Den norske stats oljeselskap a.s.
N-4035 Stavanger
Norway

☐ This person is also inventor.

Telephone No.

Facsimile No.

Teleprinter No.

State (that is, country) of nationality:

NO

State (that is, country) of residence:

NO

This person is applicant
for the purposes of:

☐ all designated
States

☒ all designated States except
the United States of America

☐ the United States
of America only

☐ the States indicated in
the Supplemental Box
Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

NILSEN Finn Patrick
Sore Furudalen 3
N-5044 Nattland
Norway

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only (If this check-box
is marked, do not fill in below)

State (that is, country) of nationality:

GB

State (that is, country) of residence:

NO

This person is applicant
for the purposes of:

☐ all designated
States

☐ all designated States except
the United States of America

☒ the United States
of America only

☐ the States indicated in
the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.
Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf
of the applicant(s) before the competent International Authorities as:

☒ agent

☐ common representative

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

REES David Christopher
Kilburn & Strode
20 Red Lion Street
London WC1R 4PJ
England

Telephone No.

0171 539 4200

Facsimile No.

0171 539 4299

Teleprinter No.

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Sheet No. 2

Continuation of Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)	
<i>If none of the following sub-boxes is used, this sheet should not be included in the request.</i>	
<p>Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)</p> <p>LINGA Harald Kringlebotn 267 N-5050 N�sttun Norway</p>	<p>This person is:</p> <p><input type="checkbox"/> applicant only</p> <p><input checked="" type="checkbox"/> applicant and inventor</p> <p><input type="checkbox"/> inventor only (If this check-box is marked, do not fill in below.)</p>
State (that is, country) of nationality: NO	State (that is, country) of residence: NO
<p>This person is applicant for the purposes of:</p> <p><input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input checked="" type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box</p>	
<p>Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)</p>	<p>This person is:</p> <p><input type="checkbox"/> applicant only</p> <p><input type="checkbox"/> applicant and inventor</p> <p><input type="checkbox"/> inventor only (If this check-box is marked, do not fill in below.)</p>
State (that is, country) of nationality:	State (that is, country) of residence:
<p>This person is applicant for the purposes of:</p> <p><input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box</p>	
<p>Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)</p>	<p>This person is:</p> <p><input type="checkbox"/> applicant only</p> <p><input type="checkbox"/> applicant and inventor</p> <p><input type="checkbox"/> inventor only (If this check-box is marked, do not fill in below.)</p>
State (that is, country) of nationality:	State (that is, country) of residence:
<p>This person is applicant for the purposes of:</p> <p><input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box</p>	
<p>Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)</p>	<p>This person is:</p> <p><input type="checkbox"/> applicant only</p> <p><input type="checkbox"/> applicant and inventor</p> <p><input type="checkbox"/> inventor only (If this check-box is marked, do not fill in below.)</p>
State (that is, country) of nationality:	State (that is, country) of residence:
<p>This person is applicant for the purposes of:</p> <p><input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box</p>	
<p>Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)</p>	<p>This person is:</p> <p><input type="checkbox"/> applicant only</p> <p><input type="checkbox"/> applicant and inventor</p> <p><input type="checkbox"/> inventor only (If this check-box is marked, do not fill in below.)</p>
State (that is, country) of nationality:	State (that is, country) of residence:
<p>This person is applicant for the purposes of:</p> <p><input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box</p>	
<p><input type="checkbox"/> Further applicants and/or (further) inventors are indicated on another continuation sheet.</p>	

Box No. V DESIGNATION OF STATES

The following designations are to be made under Rule 4.9(a) (mark the applicable check-box; at least one must be marked):

Regional Patent

- ☒ **AP ARIPO Patent:** GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SL Sierra Leone, SZ Swaziland, TZ United Republic of Tanzania, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☒ **EA Eurasian Patent:** AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ **EP European Patent:** AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☒ **OA OAPI Patent:** BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT (if other kind of protection or treatment desired, specify on dotted line)

National Patent (if other kind of protection or treatment desired, specify on dotted line):

- | | |
|---|---|
| <input checked="" type="checkbox"/> AE United Arab Emirates | <input checked="" type="checkbox"/> LR Liberia |
| <input checked="" type="checkbox"/> AL Albania | <input checked="" type="checkbox"/> LS Lesotho |
| <input checked="" type="checkbox"/> AM Armenia | <input checked="" type="checkbox"/> LT Lithuania |
| <input checked="" type="checkbox"/> AT Austria | <input checked="" type="checkbox"/> LU Luxembourg |
| <input checked="" type="checkbox"/> AU Australia | <input checked="" type="checkbox"/> LV Latvia |
| <input checked="" type="checkbox"/> AZ Azerbaijan | <input checked="" type="checkbox"/> MA Morocco |
| <input checked="" type="checkbox"/> BA Bosnia and Herzegovina | <input checked="" type="checkbox"/> MD Republic of Moldova |
| <input checked="" type="checkbox"/> BB Barbados | <input checked="" type="checkbox"/> MG Madagascar |
| <input checked="" type="checkbox"/> BG Bulgaria | <input checked="" type="checkbox"/> MK The former Yugoslav Republic of Macedonia |
| <input checked="" type="checkbox"/> BR Brazil | |
| <input checked="" type="checkbox"/> BY Belarus | <input checked="" type="checkbox"/> MN Mongolia |
| <input checked="" type="checkbox"/> CA Canada | <input checked="" type="checkbox"/> MW Malawi |
| <input checked="" type="checkbox"/> CH and LI Switzerland and Liechtenstein | <input checked="" type="checkbox"/> MX Mexico |
| <input checked="" type="checkbox"/> CN China | <input checked="" type="checkbox"/> NO Norway |
| <input checked="" type="checkbox"/> CR Costa Rica | <input checked="" type="checkbox"/> NZ New Zealand |
| <input checked="" type="checkbox"/> CU Cuba | <input checked="" type="checkbox"/> PL Poland |
| <input checked="" type="checkbox"/> CZ Czech Republic | <input checked="" type="checkbox"/> PT Portugal |
| <input checked="" type="checkbox"/> DE Germany | <input checked="" type="checkbox"/> RO Romania |
| <input checked="" type="checkbox"/> DK Denmark | <input checked="" type="checkbox"/> RU Russian Federation |
| <input checked="" type="checkbox"/> DM Dominica | <input checked="" type="checkbox"/> SD Sudan |
| <input checked="" type="checkbox"/> EE Estonia | <input checked="" type="checkbox"/> SE Sweden |
| <input checked="" type="checkbox"/> ES Spain | <input checked="" type="checkbox"/> SG Singapore |
| <input checked="" type="checkbox"/> FI Finland | <input checked="" type="checkbox"/> SI Slovenia |
| <input checked="" type="checkbox"/> GB United Kingdom | <input checked="" type="checkbox"/> SK Slovakia |
| <input checked="" type="checkbox"/> GD Grenada | <input checked="" type="checkbox"/> SL Sierra Leone |
| <input checked="" type="checkbox"/> GE Georgia | <input checked="" type="checkbox"/> TJ Tajikistan |
| <input checked="" type="checkbox"/> GH Ghana | <input checked="" type="checkbox"/> TM Turkmenistan |
| <input checked="" type="checkbox"/> GM Gambia | <input checked="" type="checkbox"/> TR Turkey |
| <input checked="" type="checkbox"/> HR Croatia | <input checked="" type="checkbox"/> TT Trinidad and Tobago |
| <input checked="" type="checkbox"/> HU Hungary | <input checked="" type="checkbox"/> TZ United Republic of Tanzania |
| <input checked="" type="checkbox"/> ID Indonesia | <input checked="" type="checkbox"/> UA Ukraine |
| <input checked="" type="checkbox"/> IL Israel | <input checked="" type="checkbox"/> UG Uganda |
| <input checked="" type="checkbox"/> IN India | <input checked="" type="checkbox"/> US United States of America |
| <input checked="" type="checkbox"/> IS Iceland | |
| <input checked="" type="checkbox"/> JP Japan | <input checked="" type="checkbox"/> UZ Uzbekistan |
| <input checked="" type="checkbox"/> KE Kenya | <input checked="" type="checkbox"/> VN Viet Nam |
| <input checked="" type="checkbox"/> KG Kyrgyzstan | <input checked="" type="checkbox"/> YU Yugoslavia |
| <input checked="" type="checkbox"/> KP Democratic People's Republic of Korea | <input checked="" type="checkbox"/> ZA South Africa |
| | <input checked="" type="checkbox"/> ZW Zimbabwe |
| <input checked="" type="checkbox"/> KR Republic of Korea | |
| <input checked="" type="checkbox"/> KZ Kazakhstan | |
| <input checked="" type="checkbox"/> LC Saint Lucia | |
| <input checked="" type="checkbox"/> LK Sri Lanka | |

Check-boxes reserved for designating States which have become party to the PCT after issuance of this sheet:

- ☒ **AG** ANTIGUA + BARBUDA
- ☒ **DZ** ALGERIA

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. (Confirmation (including fees) must reach the receiving Office within the 15-month time limit.)

Supplemental Box *If the Supplemental Box is not used, this sheet should not be included in the request.*

1. If, in any of the Boxes, the space is insufficient to furnish all the information: in such case, write "Continuation of Box No. ..." (indicate the number of the Box) and furnish the information in the same manner as required according to the captions of the Box in which the space was insufficient, in particular:

- (i) if more than two persons are involved as applicants and/or inventors and no "continuation sheet" is available; in such case, write "Continuation of Box No. III" and indicate for each additional person the same type of information as required in Box No. III. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below;
- (ii) if, in Box No. II or in any of the sub-boxes of Box No. III, the indication "the States indicated in the Supplemental Box" is checked: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the applicant(s) involved and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is applicant;
- (iii) if, in Box No. II or in any of the sub-boxes of Box No. III, the inventor or the inventor/applicant is not inventor for the purposes of all designated States or for the purposes of the United States of America: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the inventor(s) and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is inventor;
- (iv) if, in addition to the agent(s) indicated in Box No. IV, there are further agents: in such case, write "Continuation of Box No. IV" and indicate for each further agent the same type of information as required in Box No. IV;
- (v) if, in Box No. V, the name of any State (or OAPI) is accompanied by the indication "patent of addition," or "certificate of addition," or if, in Box No. V, the name of the United States of America is accompanied by an indication "continuation" or "continuation-in-part": in such case, write "Continuation of Box No. V" and the name of each State involved (or OAPI), and after the name of each such State (or OAPI), the number of the parent title or parent application and the date of grant of the parent title or filing of the parent application;
- (vi) if, in Box No. VI, there are more than three earlier applications whose priority is claimed: in such case, write "Continuation of Box No. VI" and indicate for each additional earlier application the same type of information as required in Box No. VI;
- (vii) if, in Box No. VI, the earlier application is an ARIPO application: in such case, write "Continuation of Box No. VI", specify the number of the item corresponding to that earlier application and indicate at least one country party to the Paris Convention for the Protection of Industrial Property or one Member of the World Trade Organization for which that earlier application was filed

2. If, with regard to the precautionary designation statement contained in Box No. V, the applicant wishes to exclude any State(s) from the scope of that statement: in such case, write "Designation(s) excluded from precautionary designation statement" and indicate the name or two-letter code of each State so excluded.

3. If the applicant claims, in respect of any designated Office, the benefits of provisions of the national law concerning non-prejudicial disclosures or exceptions to lack of novelty: in such case, write "Statement concerning non-prejudicial disclosures or exceptions to lack of novelty" and furnish that statement below.

Additional Representatives:

Kevin David Nicholas KEARNEY
 Richard John ASHMEAD
 Nigel Robin JENNINGS
 Andrew Gregory SHEARD
 Michael Norman MAGGS
 Peter HALE
 Paul William CHAPMAN
 James Lionel Woolverton MILLER
 Gwilym Vaughan ROBERTS
 Kristina Victoria Joy CORNISH
 Maureen Catherine KINSLER
 Julia Anne FLORENCE
 Nicholas John LEE
 Nicholas Charles BASSIL
 Punita SHAH
 Timothy Graham COPSEY

all of Kilburn & Strode, 20 Red Lion Street, London WC1R 4PJ, England

Sheet No. 5

Box No. VI PRIORITY CLAIM		<input type="checkbox"/> Further priority claims are indicated in the Supplemental Box		
Filing date of earlier application (day/month/year)	Number of earlier application	earlier application is:		
		national application: country	regional application: regional Office	international application: receiving Office
item (1) 23 03 99	9906717.5	GB		
item (2)				
item (3)				

☒ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office) identified above as item(s): (1)

* Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) (if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):

Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority):

Date (day/month/year)

Number

Country (or regional Office)

ISA /

Box No. VIII CHECK LIST; LANGUAGE OF FILING

This international application contains the following number of sheets:

request : 5

description (excluding sequence listing part) : 10

claims : 5

abstract : 1

drawings : 3

sequence listing part of description : 0

Total number of sheets : 24

This international application is accompanied by the item(s) marked below:

1. ☒ fee calculation sheet
2. ☐ separate signed power of attorney
3. ☐ copy of general power of attorney; reference number, if any:
4. ☐ statement explaining lack of signature
5. ☐ priority document(s) identified in Box No. VI as item(s):
6. ☐ translation of international application into (language):
7. ☐ separate indications concerning deposited microorganism or other biological material
8. ☐ nucleotide and/or amino acid sequence listing in computer readable form
9. ☒ other (specify): Patents Form 23/77

Figure of the drawings which should accompany the abstract: 2

Language of filing of the international application: English

Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

David Christopher REES - Authorised Representative

For receiving Office use only	
1. Date of actual receipt of the purported international application:	2. Drawings: <input type="checkbox"/> received: <input type="checkbox"/> not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:	
4. Date of timely receipt of the required corrections under PCT Article 11(2):	
5. International Searching Authority (if two or more are competent): ISA /	6. <input type="checkbox"/> Transmittal of search copy delayed until search fee is paid.

For International Bureau use only	
Date of receipt of the record copy by the International Bureau:	

INTERNATIONAL SEARCH REPORT

Intern. Application No

GB 00/01070

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C10L3/10 B01D53/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C10L B01D C10G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 301 048 A (KCC PROCESS EQUIPMENT LTD) 27 November 1996 (1996-11-27) the whole document	1,6,9, 13,15, 19,23, 24,27,30
A	US 4 279 628 A (WYMER ROBERT L ET AL) 21 July 1981 (1981-07-21)	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *8* document member of the same patent family

Date of the actual completion of the international search

26 June 2000

Date of mailing of the international search report

05/07/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

De Herdt, O

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern. Application No

T/GB 00/01070

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
GB 2301048	A	27-11-1996	NONE	
US 4279628	A	21-07-1981	NONE	

From the

INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

Received

PCT Rec'd 21 SEP 2001

To:

REES, David, Christopher
Kilburn & Strode
20 Red Lion Street
London WC1R 4PJ
GRANDE BRETAGNE

Date:

27 JUN 2001

Entered:

Checked:

F/E

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT
(PCT Rule 71.1)

PCT

Date of mailing
(day/month/year)

25.06.01

Applicant's or agent's file reference

DCR P21205WO

IMPORTANT NOTIFICATION

International application No.

PCT/GB00/01070

International filing date (day/month/year)

21/03/2000

Priority date (day/month/year)

23/03/1999

Applicant

DEN NORSKE STATS OLJESELSKAP A.S. et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/



European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized officer

Michaleczek, N


Tel. +49 89 2399-7254



PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference DCR P21205WO		FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/GB00/01070	International filing date (day/month/year) 21/03/2000	Priority date (day/month/year) 23/03/1999	
International Patent Classification (IPC) or national classification and IPC C10L3/10			
Applicant DEN NORSKE STATS OLJESELSKAP A.S. et al.			
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet.</p> <p><input type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of sheets.</p>			
<p>3. This report contains indications relating to the following items:</p> <p>I <input checked="" type="checkbox"/> Basis of the report</p> <p>II <input type="checkbox"/> Priority</p> <p>III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p>IV <input type="checkbox"/> Lack of unity of invention</p> <p>V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p>VI <input type="checkbox"/> Certain documents cited</p> <p>VII <input type="checkbox"/> Certain defects in the international application</p> <p>VIII <input checked="" type="checkbox"/> Certain observations on the international application</p>			
Date of submission of the demand 16/10/2000		Date of completion of this report 25.06.01	
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465		Authorized officer Falls, F Telephone No. +49 89 2399 8350	



**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB00/01070

I. Basis of the report

1. With regard to the elements of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 1.4 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*)

Description, pages:

1-10 as originally filed

Claims, No.:

1-32 as originally filed

Drawings, sheets:

1/3-3/3 as originally filed

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
☐ the language of publication of the international application (under Rule 48.3(b)).
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
☐ filed together with the international application in computer readable form.
☐ furnished subsequently to this Authority in written form.
☐ furnished subsequently to this Authority in computer readable form.
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☐ the claims, Nos.:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB00/01070

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims 1-32
	No: Claims
Inventive step (IS)	Yes: Claims 1-29
	No: Claims 30-32
Industrial applicability (IA)	Yes: Claims 1-32
	No: Claims

2. Citations and explanations
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

I

1). Prior Art

US-A-4279628(D1) discloses a vessel for drying gas in which gas is introduced via a venturi inlet into a mixing zone where turbulent mixing takes place, the gas and liquid being removed through separate outlets.

2). Novelty (Art. 33(2) PCT)

D1 does not disclose the following features of the claims:

- The venturi leads from the liquid-gas outlet.
- In claim 1 the liquid and gas are led out through the same outlet; in D1 they exit through separate outlets.
- The internal tube which is either perforated or spaced from the periphery of the outlet.

Therefore the subject-matter of the claims is novel.

3). Inventive Step (Art. 33(3) PCT)

The problem is to improve the method for removing water vapour from natural gas.

The inventive concept resides in the combination of the turbulent contactor and tube followed by drawing of the liquid and gas mixture through the outlet into the venturi, which allows for rapid and efficient mixing in a relatively small total volume giving efficient absorption (see pg 3, l. 19-30). Therefore the subject-matter of claims 1-29 is inventive.

In view of the fact that claims 30-32 for the use of the turbulent contractor for absorbing water from a natural gas stream do not contain all features essential for carrying out this aspect of the invention (see section II(1) below), the subject-matter of these claims is not inventive across the breadth of the claims.

II

The following matters arise under Art. 6 PCT:

1). It is clear from the description on page 3 that the following features are essential to the definition of the invention:

- (i) The tube being perforated and/or spaced from the periphery outlet.
- (ii) Subjecting the natural gas and liquid to turbulent mixing.

Since independent claim 30 for the use of the apparatus of claim 24 does not contain these features it does not meet the requirement following from Article 6 PCT taken in combination with Rule 6.3(b) PCT that any independent claim must contain all the technical features essential to the definition of the invention.

2). Claims 2 and 25 appear to be superfluous since it seems that in accordance with the definition of the process in claim 1 "the tube extending from the outlet back upstream" would necessarily be located inside the turbulent contacting vessel along with the gas and liquid inlets and the outlet (e.g as in Fig 2). It appears therefore that these claims should be deleted.

3). The passage on pg 3, l. 14-16 suggests that the scope of protection may be extended to gases other than natural gas without giving any teaching as to what these are. Therefore since the passage suggests that the scope of protection may be extended in an undefined way, it should be deleted.

4). The word "preferably" on pg 4, l. 8 should be deleted since the feature referred to is essential (see (2) above).

From the INTERNATIONAL SEARCHING AUTHORITY

PCTNOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL SEARCH REPORT
OR THE DECLARATION

(PCT Rule 44.1)

To:

KILBURN & STRODE
Attn. REES, D.
20 Red Lion Street
London WC1R 4PJ
UNITED KINGDOMDate of mailing
(day/month/year)

05/07/2000

Applicant's or agent's file reference

DCR P21205WO

FOR FURTHER ACTION

See paragraphs 1 and 4 below

International application No.

PCT/GB 00/01070

International filing date
(day/month/year)

21/03/2000

Applicant

DEN NORSKE STATS OLJESELSKAP A.S.

- 1.
- ☒
- The applicant is hereby notified that the International Search Report has been established and is transmitted herewith.

Filing of amendments and statement under Article 19:

The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

When? The time limit for filing such amendments is normally 2 months from the date of transmittal of the International Search Report; however, for more details, see the notes on the accompanying sheet.**Where?** Directly to the International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Fascimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

- 2.
- ☐
- The applicant is hereby notified that no International Search Report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

- 3.
- ☐
- With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

- 4.
- Further action(s):**
- The applicant is reminded of the following:

Shortly after 18 months from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90bis.1 and 90bis.3, respectively, before the completion of the technical preparations for international publication.

Within 19 months from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within 20 months from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the International Searching Authority

European Patent Office, P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Toñi Muñoz-Manneken

NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the PCT Applicant's Guide, a publication of WIPO.

In these Notes, "Article", "Rule", and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions respectively.

INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only.

What parts of the international application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

When?

Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

How?

Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Administrative Instructions, Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

What documents must/may accompany the amendments?

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

NOTES TO FORM PCT/ISA/220 (continued)

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped), whether

- (i) the claim is unchanged;
- (ii) the claim is cancelled;
- (iii) the claim is new;
- (iv) the claim replaces one or more claims as filed;
- (v) the claim is the result of the division of a claim as filed.

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."
2. [Where originally there were 15 claims and after amendment of all claims there are 11]:
"Claims 1 to 15 replaced by amended claims 1 to 11."
3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."
4. [Where various kinds of amendments are made]:
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

"Statement under article 19(1)" (Rule 48.4)

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

It must be in the language in which the international application is to be published.

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

Consequence if a demand for international preliminary examination has already been filed

If, at the time of filing any amendments under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the same time of filing the amendments with the International Bureau, also file a copy of such amendments with the International Preliminary Examining Authority (see Rule 62.2(a), first sentence).

Consequence with regard to translation of the international application for entry into the national phase

The applicant's attention is drawn to the fact that, where upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see Volume II of the PCT Applicant's Guide.

From the

INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

Received

To:

REES, David, Christopher
Kilburn & Strode
20 Red Lion Street
London WC1R 4PJ
GRANDE BRETAGNE

Date:

27 JUN 2001

Entered:

Checked:

F/E

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT

(PCT Rule 71.1)

PCT

Date of mailing
(day/month/year)

25.06.01

Applicant's or agent's file reference

DCR P21205WO

IMPORTANT NOTIFICATION

International application No.

PCT/GB00/01070

International filing date (day/month/year)

21/03/2000

Priority date (day/month/year)

23/03/1999

Applicant

DEN NORSKE STATS OLJESELSKAP A.S. et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/



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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference DCR P21205WO	<div style="display: flex; justify-content: space-between;"> FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416) </div>	
International application No. PCT/GB00/01070	International filing date (<i>day/month/year</i>) 21/03/2000	Priority date (<i>day/month/year</i>) 23/03/1999
International Patent Classification (IPC) or national classification and IPC C10L3/10		
Applicant DEN NORSKE STATS OLJESELSKAP A.S. et al.		
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet.</p> <p><input type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of sheets.</p>		
<p>3. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"> I <input checked="" type="checkbox"/> Basis of the report II <input type="checkbox"/> Priority III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability IV <input type="checkbox"/> Lack of unity of invention V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement VI <input type="checkbox"/> Certain documents cited VII <input type="checkbox"/> Certain defects in the international application VIII <input checked="" type="checkbox"/> Certain observations on the international application 		
Date of submission of the demand 16/10/2000	Date of completion of this report 25.06.01	
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Falls, F Telephone No. +49 89 2399 8350 <div style="text-align: right;">  </div>	

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB00/01070

I. Basis of the report

1. With regard to the elements of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-10 as originally filed

Claims, No.:

1-32 as originally filed

Drawings, sheets:

1/3-3/3 as originally filed

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB00/01070

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-32
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-29
	No:	Claims	30-32
Industrial applicability (IA)	Yes:	Claims	1-32
	No:	Claims	

2. Citations and explanations
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

1). Prior Art

US-A-4279628(D1) discloses a vessel for drying gas in which gas is introduced via a venturi inlet into a mixing zone where turbulent mixing takes place, the gas and liquid being removed through separate outlets.

2). Novelty (Art. 33(2) PCT)

D1 does not disclose the following features of the claims:

- The venturi **leads from** the liquid-gas outlet.
- In claim 1 the liquid and gas are led out through the same outlet; in D1 they exit through separate outlets.
- The internal tube which is either perforated or spaced from the periphery of the outlet.

Therefore the subject-matter of the claims is novel.

3). Inventive Step (Art. 33(3) PCT)

The problem is to improve the method for removing water vapour from natural gas.

The inventive concept resides in the combination of the turbulent contactor and tube followed by drawing of the liquid and gas mixture through the outlet into the venturi, which allows for rapid and efficient mixing in a relatively small total volume giving efficient absorption (see pg 3, l. 19-30). Therefore the subject-matter of claims 1-29 is inventive.

In view of the fact that claims 30-32 for the use of the turbulent contractor for absorbing water from a natural gas stream do not contain all features essential for carrying out this aspect of the invention (see section II(1) below), the subject-matter of these claims is not inventive across the breadth of the claims.

II

The following matters arise under Art. 6 PCT:

1). It is clear from the description on page 3 that the following features are essential to the definition of the invention:

- (i) The tube being perforated and/or spaced from the periphery outlet.
- (ii) Subjecting the natural gas and liquid to turbulent mixing.

Since independent claim 30 for the use of the apparatus of claim 24 does not contain these features it does not meet the requirement following from Article 6 PCT taken in combination with Rule 6.3(b) PCT that any independent claim must contain all the technical features essential to the definition of the invention.

2). Claims 2 and 25 appear to be superfluous since it seems that in accordance with the definition of the process in claim 1 "the tube extending from the outlet back upstream" would necessarily be located inside the turbulent contacting vessel along with the gas and liquid inlets and the outlet (e.g as in Fig 2). It appears therefore that these claims should be deleted.

3). The passage on pg 3, l. 14-16 suggests that the scope of protection may be extended to gases other than natural gas without giving any teaching as to what these are. Therefore since the passage suggests that the scope of protection may be extended in an undefined way, it should be deleted.

4). The word "preferably" on pg 4, l. 8 should be deleted since the feature referred to is essential (see (2) above).



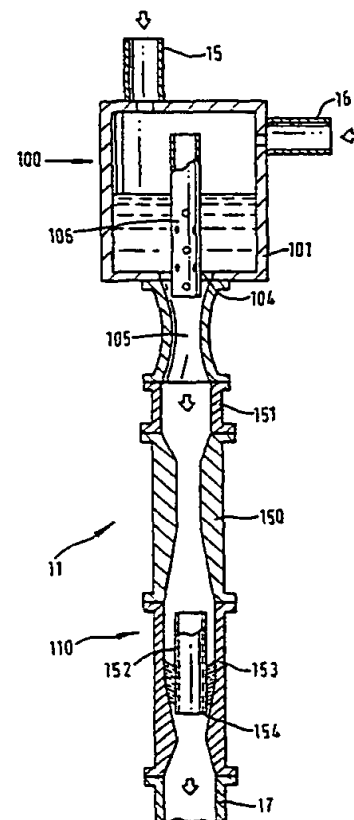
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : C10L 3/10, B01D 53/26	A1	(11) International Publication Number: WO 00/56844 (43) International Publication Date: 28 September 2000 (28.09.00)
<p>(21) International Application Number: PCT/GB00/01070</p> <p>(22) International Filing Date: 21 March 2000 (21.03.00)</p> <p>(30) Priority Data: 9906717.5 23 March 1999 (23.03.99) GB</p> <p>(71) Applicant (for all designated States except US): DEN NORSKE STATS OLJESELSKAP A.S. [NO/NO]; N-4035 Stavanger (NO).</p> <p>(72) Inventors; and (75) Inventors/Applicants (for US only): NILSEN, Finn, Patrick [GB/NO]; Sore Furudalen 3, N-5044 Nattland (NO). LINGA, Harald [NO/NO]; Kringlebotn 267, N-5050 Nesttun (NO).</p> <p>(74) Agents: REES, David, Christopher et al.; Kilburn & Strode, 20 Red Lion Street, London WC1R 4PJ (GB).</p>		<p>(81) Designated States: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p>Published With international search report.</p>

(54) Title: METHOD AND APPARATUS FOR THE DRYING OF NATURAL GAS

(57) Abstract

A system for removing water from natural gas which comprises: bringing the natural gas into contact with a liquid including an absorbent for the water; subjecting the natural gas and liquid to turbulent mixing conditions thereby causing the water to be absorbed by the absorbent; and separating a natural gas phase with reduced water content and a liquid phase including the absorbent and absorbed water. The mixing is conducted in a turbulent contactor (11) including a gas inlet (15), a liquid inlet (16), an outlet (104) leading to a venturi passage (105) and a tube (106) extending from the outlet (104) back upstream. The tube (106) may be perforated and/or spaced from the periphery of the outlet (104).



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PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference DCR P21205W0	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/GB 00/ 01070	International filing date (day/month/year) 21/03/2000	(Earliest) Priority Date (day/month/year) 23/03/1999
Applicant DEN NORSKE STATS OLJESELSKAP A.S.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the title,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

2

☐ None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No

GB 00/01070

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C10L3/10 B01D53/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C10L B01D C10G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 301 048 A (KCC PROCESS EQUIPMENT LTD) 27 November 1996 (1996-11-27) the whole document	1, 6, 9, 13, 15, 19, 23, 24, 27, 30
A	US 4 279 628 A (WYMER ROBERT L ET AL) 21 July 1981 (1981-07-21)	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

26 June 2000

Date of mailing of the international search report

05/07/2000

Name and mailing address of the ISA

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Authorized officer

De Herdt, 0

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

/GB 00/01070

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
GB 2301048	A	27-11-1996	NONE	
US 4279628	A	21-07-1981	NONE	

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Method and Apparatus for the Drying of Natural Gas

The present invention is concerned with a method and apparatus for the removal of water from natural gas.

5 Natural gas as extracted from reservoirs contains water vapour. The concentration of the water vapour depends on the temperature and pressure of the gas at the extraction point. During the processing of the gas, particularly if it is treated to remove acid gas
10 components such as carbon dioxide, CO_2 , and hydrogen sulphide, H_2S , it may come into contact with aqueous solvents. This means that the gas may pick up further water vapour. When the gas is contacted with an aqueous solvent, it will become saturated with water vapour at the
15 prevailing temperature and pressure. Before the gas is exported from the production facility the water vapour concentration in the gas must be reduced to very low levels. A typical specification may be 0.2 parts per million by volume (ppm v/v) of water in the gas. This is
20 well below the concentrations which will normally be in the gas as extracted and well below the value after processing to remove CO_2 and/or H_2S . The gas, therefore has to be dried before it can be compressed for export.

25 Currently, the processes are generally used to dry a gas. These are based on absorption or adsorption respectively. In the adsorption, the gas is contacted with a porous solid material. The water vapour adsorbs onto the surface of the solid. The adsorbent is usually a silicious material, typically a mixture of aluminium and
30 silica oxides known as molecular sieves. In absorption the gas is contacted with a chemical reagent which removes the water. The present application is concerned with absorption drying-dehydration processes.

In conventional drying processes alcohols, usually

the glycols, monoethylene glycol, MEG, or triethylene glycol, TEG, are contacted with gas in a countercurrent tower. The gas is normally saturated with water vapour at the inlet conditions, temperature and pressure. The saturation concentration increases with increasing temperature and decreasing pressure. In a typical set of conditions, 80 °C and 70B (7 x 10⁶ Pa) pressure, the saturation concentration is 8 x 10⁻³ kg/mmscm of gas. The concentration of water in the outlet gas will vary slightly with conditions on pipe line specifications but is typically of the order of 6.4 x 10⁻⁵ kg/mmscm of gas. This corresponds to a water dew point at 70Bg of -7 °C, well below the hydrate formation point.

In order to assess the absorption duty between these low concentrations, the thermodynamic equilibrium data - concentration of water in the gas, y^* , and concentration of water in the liquid phase, x - is required. Note:-

$$y^*_p = f(x)_p \quad (1)$$

i.e., the function f is dependent on the pressure. The relevant data shows that the separation can be achieved in one theoretical stage, i.e. if equilibrium were achieved in the contacting (mixing) process, then one contact between the gas and liquid should give the required duty of water removal from the gas.

However, in conventional countercurrent tower units, 4 actual stages are normally specified. Stage efficiencies greater than 50% are simply not achieved.

It is therefore an object of the invention to provide a method and apparatus which enables water vapour to be removed from a natural gas with greater efficiency.

According to the invention, there is provided a method of removing water from natural gas which comprises: bringing the natural gas into contact with a liquid including an absorbent for the water; subjecting the natural gas and liquid to turbulent mixing conditions
5 thereby causing the water to be absorbed by the absorbent; and separating a natural gas phase with reduced water content and a liquid phase including the absorbent and absorbed water; and in which the mixing is conducted in a turbulent contactor including a gas inlet, a liquid inlet,
10 an outlet leading to a venturi passage and a tube extending from the outlet back upstream, the tube being perforated and/or being spaced from the periphery of the outlet.

While the invention has been described in relation to natural gas, it is equally applicable to other gases with
15 a water content which it is desirable to reduce.

The invention also extends to the apparatus for carrying out this method.

The turbulent mixing is very intense and results in extremely efficient gas liquid contact. The mixing regime is preferably turbulent shear layer mixing. The liquid entrained in the gas may be in the form of droplets for gas continuous fluid phase distribution. The efficient mixing means that absorption can take place very rapidly and in a relatively small total volume of absorbent compared to that
25 required in conventional absorption columns. The mixing system used is simple and inexpensive compared to prior art systems, leading to reduced costs. Finally, an efficiency of approaching 100% for the removal of water can be
30 achieved for certain applications.

The advantages of such a mixer in relation to conventional countercurrent dehydration towers are a reduction in the size and weight of the equipment.

Preferably, the method is carried out as a continuous process with the natural gas and liquid flowing co-currently. The co-current flow reduces the problems associated with foaming and flooding, since absorption can continue downstream of the contactor.

One suitable contactor is a mixer supplied by Framo Engineering A/S and is described in EP-B-379319.

Preferably, the tube is located in a vessel, the vessel including the gas inlet, the liquid inlet and the outlet. In one possible regime, the natural gas is supplied to the tube, optionally directly, and the liquid is supplied to the vessel, and so the natural gas stream draws the liquid into the venturi and the two phases are mixed. In another regime, the natural gas is supplied to the vessel and the liquid is supplied to the tube, optionally directly, whereby the natural gas is drawn into the venturi by the liquid and the two phases are mixed. In a third regime, the liquid and the natural gas are supplied to the vessel, the liquid being supplied to a level above the level of the outlet, whereby the natural gas is forced out through the outlet via the tube, thereby drawing the liquid into the venturi so that the two phases are mixed.

Preferably, the natural gas and the liquid are formed into a homogeneous mixture in the contactor, the homogeneous mixtures optionally being cooled prior to separation into a gas phase and a liquid phase. Preferably, the homogeneous mixture is separated into a gas phase and a liquid phase in a hydrocyclone. Preferably, the absorbent in the liquid phase is subjected to a regeneration treatment to remove the absorbed water. Preferably, the regenerated absorbent-containing liquid phase is recycled to the contactor. Preferably, the regeneration is carried out by heating and/or by flashing off the water. Where the absorbent is a glycol,

regeneration may be carried out by heating the solution to about 200 °C and passing the vapours to a fractionating tower. Preferably, the post-mixing cooling and the regenerative heating are achieved, at least in part by mutual heat exchange.

Partial recovery of the glycol may be attained by flashing off the water vapour by reducing the applied pressure on the liquid after gas dehydration. Where this is used then a similar turbulent mixer may be considered for this duty. This flashing operation will only give a partial glycol regeneration. In order to get to the very low levels of water content of the glycol solutions necessary for gas dehydration, heating of the solvent phase is required.

According to a more specific aspect of the invention, there is provided a method for removing water from a natural gas which comprises: supplying the natural gas to a turbulent contactor; supplying a liquid including an absorbent for the water to the contactor; subjecting the natural gas and the liquid to turbulent mixing in the contactor to form a homogeneous mixture; allowing the water to be absorbed by the absorbent; separating the homogeneous mixture into a gas phase and a liquid phase in a hydrocyclone (or any other gas/liquid separator); removing the gas phase; subjecting the solvent in the liquid phase to a regeneration treatment to remove the absorbed water; and recycling the regenerated absorbent-containing liquid phase to the contactor.

A portion of the solvent, after extraction may be recycled directed to the contactor.

Preferably, the absorbent includes a glycol or another water-miscible liquid. Preferably, the glycol is ethylene glycol, diethylene glycol, triethylene glycol or a mixture of any of these. The chosen absorbent could also be

immiscible with water and in this case, a facility for separating the water from the absorbent would need to be introduced downstream of the gas/liquid separator.

Diethylene glycol (DEG) and monoethylene glycol (MEG) are typical solvents for dehydration. Triethylene glycol (TEG) is currently the most popular solvent since it has a higher degradation temperature and can be regenerated to a higher lean concentration with no modification to a standard boiler. There has recently been a trend towards the reduction in BTEX (benzene, toluene, ethylbenzene, xylene) emissions which has in some cases favoured the use of MEG due to the much lower solubility of BTEX in this solvent. The penalty, however, is much higher glycol losses. The present invention envisages the use of any dehydration agent. However, the short residence time in the preferred contactor system (as compared with a counter-current absorption column) will necessarily result in less co-absorption of BTEX components in a given glycol system.

Preferably the natural gas and liquid are subjected to two or more mixing steps. Additional mixing steps may be carried out before and/or after the turbulent mixing step. One or more (or indeed all) of the additional mixing steps may themselves be turbulent mixing steps. They might be carried out using a similar turbulent contactor, or some other turbulent contactor, such as an ejector, a jet pump, or a mixer as described in WO 95/02448. Preferably, there are two or more turbulent mixing steps.

When second turbulent mixing is adopted, it is preferably conducted in a turbulent contactor comprising at least one fluid inlet, an outlet leading to a venturi passage, and a tube extending from the outlet back into the contactor. Preferably, the second contactor has a gas inlet and a liquid inlet. The tube may or may not be perforated, and the gap between the tube and the outlet may

be varied. Preferably, the second turbulent contactor is located in a pipe extending from the venturi section of the first contactor. The second turbulent contactor may also have a separate liquid inlet for the addition of fresh
5 absorbent.

The invention also extends to apparatus for carrying out such a method, comprising: a turbulent contactor having a liquid inlet, a gas inlet and a fluid outlet; an optional cooler for the fluid stream from the fluid outlet; a
10 hydrocyclone arranged to separate the fluid stream into a gas phase and a liquid stream; a regenerator arranged to treat the separated liquid stream; and a recycle line arranged to convey the regenerated liquid stream to the contactor.

The apparatus may include a recycle line for the liquid stream from the separator to the contactor, by-passing the regenerator. There may also be a further separator, for example, in the form of a flash tank, in the recycle line to allow absorbed water to be released from
15 the liquid.
20

The apparatus may include a pump arranged to supply liquid to the liquid inlet of the contactor. Preferably, the regenerator is a heater and/or a flash tank.

The invention may be considered to extend to the use
25 of a turbulent contactor to remove water from natural gas by forming a homogeneous mixture of the gas mixture with an absorbent for the water in the contactor, allowing the water to be absorbed by the absorbent, and subsequently separating a gas phase and a liquid phase, the liquid phase
30 thereby containing the water.

The invention may be put into practice in various ways and some embodiments will be described by way of example to illustrate the invention with reference to the accompanying drawings, in which:

Figure 1 is a flow diagram of a process in accordance with the invention;

Figure 2 is a view of the contacting section of the apparatus; and

5 Figure 3 is a view of the glycol separation and regeneration sections.

Figure 1 shows a process for removing water from a gas stream, in accordance with the invention. The process comprises a turbulent contactor stage 11, a gas liquid
10 separator 12, a depressurizer 13 and a glycol regeneration stage 14. Water-bearing natural gas is fed to the contactor at 15 and a triethylene glycol (TEG) absorbent at 16. In the contactor 11, the TEG absorbs the water from the natural gas and a homogeneous gas/liquid mixture leaves
15 the contactor at 17.

The mixture is conveyed via line 18 to the separator 12 where the gas and liquid phases are separated. A water-free gas phase leaves the separator 12 at 19 and a liquid phase, comprising TEG and absorbed water is removed at 21.

20 This liquid phase is conveyed via a line 22 to a depressuriser 13 where water vapour is flashed off and removed via a water vapour outlet 23. The TEG with the remaining water is conveyed via a line 24 to the glycol regeneration stage 14, from which glycol is removed via a
25 glycol outlet 25 and water is removed via a water outlet 26. The regenerated glycol can be recycled to the glycol inlet 16 to the contactor stage 11.

The contactor stage 11 is shown in more detail in Figure 2. This stage 11 comprises two stages. The
30 turbulent contactor 100 forming the first stage comprises a vessel 101 having the natural gas inlet 15, the glycol inlet 16 and an outlet 104 leading to a venturi passage 105. There is a tube 106 (which may or may not be perforated) extending from the outlet 104 back into the

vessel 101.

The glycol and the natural gas are supplied to the vessel 101, the glycol being supplied to a level above the level of the outlet 104, whereby the gas is forced out through the outlet 104 via the tube 106, thereby drawing the glycol into the venturi so that the two phases are mixed.

The homogeneous gas/liquid mixture from the first turbulent contactor 100 is conveyed to a second turbulent contactor 110. Thus, the mixture enters an annular flow generator 150 from a spool piece 151, or directly from the diffuser of the venturi 105. As the gas/liquid mixture flows through the expanding outlet part of the annular flow generator 150, a liquid film establishes at the wall to form an annular gas/liquid flow essentially with the gas in the pipe core and the liquid at the pipe wall. The liquid film will be maintained in the annulus between inner and outer pipes 152 and 153 respectively.

The conditions at the outlet 154 of the inner pipe 152 are similar to the conditions at the outlet 104 of the first turbulent contactor. It is clear that, in principle, any number of stages can be added to the system, although considerations such as pressure drop should be taken into account.

As shown in Figure 2, the mixture leaving the second contactor 110 at the outlet 17 is conveyed to a hydrocyclone gas liquid separator 12 via a tangential inlet 31 (see Fig. 3). The two phases present are separated in the normal way. The gas phase, comprising dehydrated natural gas, passes upwards via a centre tube 32 and two demistor stages 33,34, and leaves via the gas outlet 19. The liquid phase, comprising glycol and absorbed water, passes downwards via a conical collector 35 and leaves via the liquid outlet 21. Accumulated liquid can be drained

from tubes at 37 at the level of the support ring for the centre tube 32.

5 The liquid is conveyed to a depressuriser 13, where some of the absorbed water is flashed off and leaves via the water vapour outlet 23. The glycol and any remaining absorbed water is pumped to the glycol regenerator 14 via the line 24. Here, the remaining absorbed water is separated from the glycol. The water is removed via the outlet 25 and dehydrated glycol is removed via the glycol outlet 26.
10 This regenerated glycol is then recycled to the glycol inlet 16 to the contactor stage 11, via a recycle line 36.

Claims:

1. A method of removing water from natural gas which comprises: bringing the natural gas into contact with a liquid including an absorbent for the water; subjecting the natural gas and liquid to turbulent mixing conditions thereby causing the water to be absorbed by the absorbent; and separating a natural gas phase with reduced water content and a liquid phase including the absorbent and absorbed water; and in which the mixing is conducted in a turbulent contactor including a gas inlet, a liquid inlet, an outlet leading to a venturi passage and a tube extending from the outlet back upstream, the tube being perforated and/or being spaced from the periphery of the outlet.
2. A method as claimed Claim 1, in which the tube is located in a vessel, the vessel including the gas inlet, the liquid inlet and the outlet.
3. A method as claimed in Claim 2, in which the natural gas is supplied to the tube and the liquid is supplied to the vessel, and so the natural gas stream draws the liquid into the venturi and the two phases are mixed.
4. A method as claimed in Claim 2, in which the natural gas is supplied to the vessel and the liquid is supplied to the tube, whereby the natural gas is drawn into the venturi by the liquid and the two phases are mixed.
5. A method as claimed in Claim 2, in which the liquid and the natural gas are supplied to the vessel, the liquid being supplied to a level above the level of the outlet, whereby the natural gas is forced out through the outlet

via the tube, thereby drawing the liquid into the venturi so that the two phases are mixed.

5 6. A method as claimed in any preceding Claim, in which the method is carried out as a continuous process with the natural gas and liquid flowing co-currently.

10 7. A method as claimed in any preceding Claim, in which the natural gas and the liquid are formed into a homogeneous mixture in the contactor, the homogeneous mixture optionally being cooled prior to separation into a gas phase and a liquid phase.

15 8. A method as claimed in Claim 7, in which the homogeneous mixture is separated into a gas phase and a liquid phase in a hydrocyclone.

20 9. A method as claimed in any preceding Claim, in which the absorbent in the liquid phase is subjected to a regeneration treatment to remove the absorbed water.

25 10. A method as claimed in Claim 9, in which the regenerated absorbent-containing liquid phase is recycled to the contactor.

11. A method as claimed in Claim 10, in which the regeneration is carried out by heating and/or by flashing off the absorbed water.

30 12. A method as claimed in Claim 11, in which the post-mixing cooling and the regenerative heating are achieved, at least in part by mutual heat exchange.

13. A method as claimed in any preceding Claim, in which the absorbent is miscible with water.
14. A method as claimed in any of Claims 1 to 12, in which
5 the absorbent is immiscible with water.
15. A method as claimed in any of Claims 1 to 12, in which the absorbent includes a glycol.
- 10 16. A method as claimed in Claim 15, in which the absorbent is monoethylene glycol, diethylene glycol, triethylene glycol or a mixture of any of these.
- 15 17. A method as claimed in any preceding Claim, in which the natural gas and liquid are subjected to two or more mixing steps.
18. A method as claimed in Claim 17, in which an additional mixing step is carried out before the turbulent
20 mixing step.
19. A method as claimed in Claim 17 or Claim 18, in which an additional mixing step is carried out after the turbulent mixing step.
- 25 20. A method as claimed in Claim 18 or Claim 19 in which one or more additional mixing steps are turbulent mixing steps.
- 30 21. A method as claimed in Claim 20, in which the second mixing step is carried out in a second contactor, located in a pipe extending from the venturi passage of the first contactor.

22. A method as claimed in Claim 21, in which the fluid mixture is separated into a gas phase and a liquid phase between the two contactors, the phase separation preferably occurring in an annular flow generator.

5

23. A method as claimed in any of Claims 17 to 22, in which fresh liquid solvent is added to the second contactor.

10

24. Apparatus for removing water from natural gas by bringing the natural gas into contact with a liquid including an absorbent for the water, comprising: a turbulent contactor in which the natural gas and liquid are subjected to turbulent mixing conditions thereby causing
15 the water to be absorbed by the absorbent; and a separator for separating a natural gas phase with reduced water content and a liquid phase including the absorbent and absorbed water; and in which the turbulent contactor comprises a gas inlet, a liquid inlet, an outlet leading to
20 a venturi passage and a tube extending from the outlet back upstream, the tube being perforated and/or being spaced from the periphery of the outlet.

25

25. Apparatus as claimed Claim 24, in which the tube is located in a vessel, the vessel including the gas inlet, the liquid inlet and the outlet.

30

26. Apparatus as claimed in Claim 24 or Claim 25, in which the separator includes a hydrocyclone.

27. Apparatus as claimed in any of Claims 24 to 26, in which the separator includes an absorbent regenerator.

28. Apparatus as claimed in any of Claims 24 to 27, in which the contactor includes two or more contactor steps.

5 29. Apparatus as claimed in Claim 28, in which the second turbulent contactor is located in a pipe extending from the venturi section of the first contactor.

10 30. The use of one or more turbulent contactor for absorbing water from a natural gas stream, in which the gas stream is brought into contact with a liquid including an absorbent for water, at least one of the turbulent contactors comprising a gas inlet, a liquid inlet, an outlet leading to a venturi passage and a tube extending from the outlet back upstream.

15

31. A use as claimed in Claim 30, in which the second turbulent contactor is located in a pipe extending from the venturi section of the first contactor.

20 32. A use as claimed in Claim 30 or Claim 31, in which a gas phase and a liquid phase are separated after exit from a first turbulent contactor before entry into a second turbulent contactor, the phase separation preferably occurring in an annular flow generator.

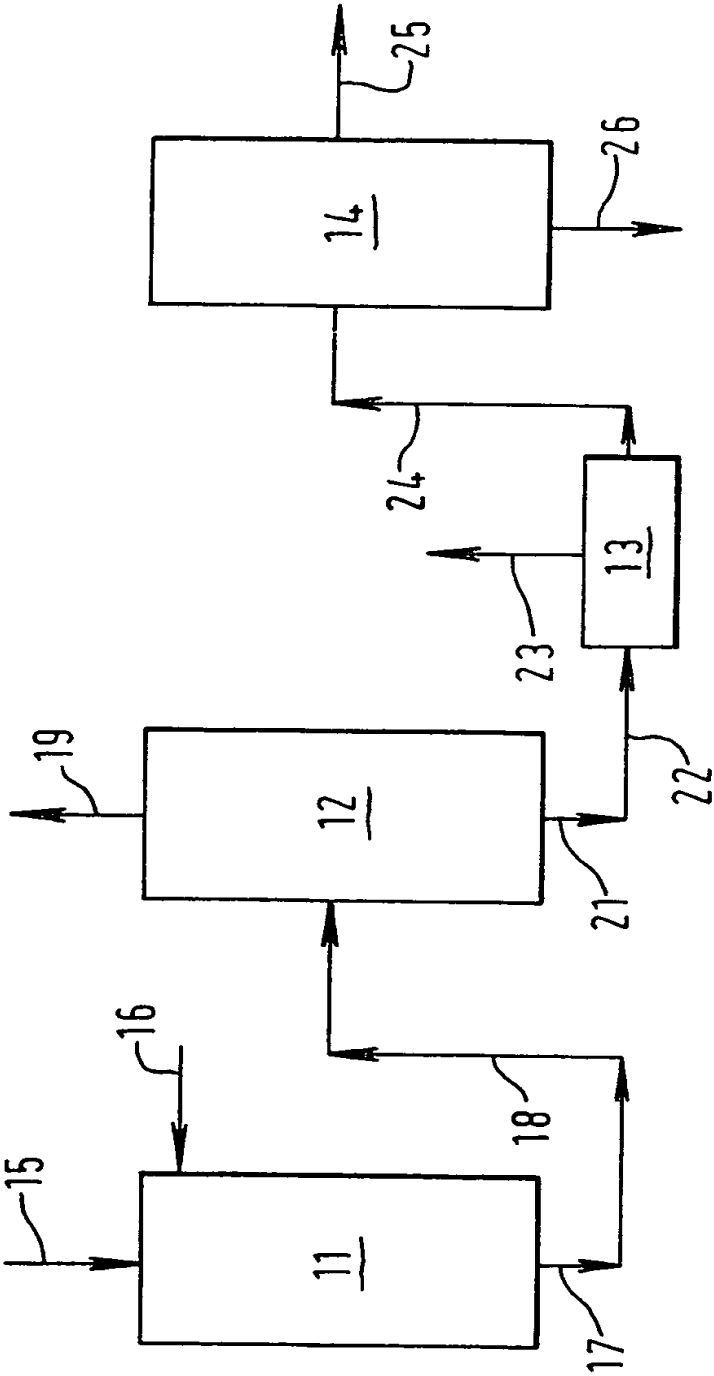
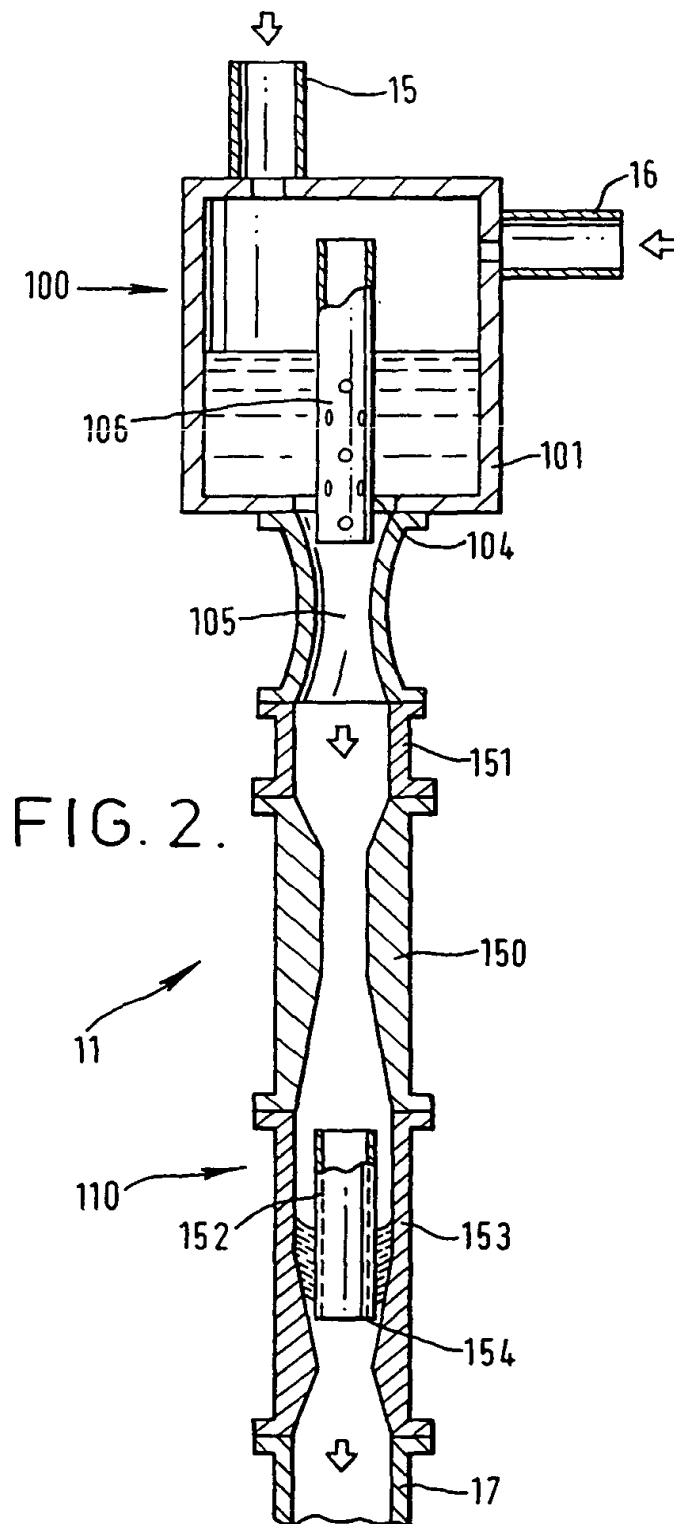


FIG.1.

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INTERNATIONAL SEARCH REPORT

Intern. Application No

PCT/GB 00/01070

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C10L3/10 B01D53/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C10L B01D C10G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 301 048 A (KCC PROCESS EQUIPMENT LTD) 27 November 1996 (1996-11-27) the whole document	1,6,9, 13,15, 19,23, 24,27,30
A	US 4 279 628 A (WYMER ROBERT L ET AL) 21 July 1981 (1981-07-21)	

☐

Further documents are listed in the continuation of box C.

☒

Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
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- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

26 June 2000

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern. Application No

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2301048 A	27-11-1996	NONE	
US 4279628 A	21-07-1981	NONE	